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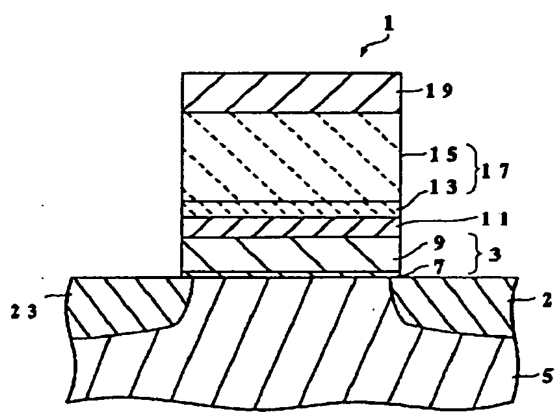
(54)【発明の名称】　結晶性薄膜製造方法

(57)【要約】
【目的】　配向性に優れた結晶構造を有する薄膜を短時間で形成する方法を提供する。
【構成】　基板５上面に配向性に優れたチタン結晶体７を形成した後に成長速度の早い成膜条件でチタン結晶性薄膜９を成長させているから、チタン結晶体７の優れた配向性を受継いだチタン結晶性薄膜３を短時間で形成することができる。チタン結晶性薄膜３上面に白金薄膜１１及びＰＺＴ薄膜をこの順で形成する。この際、ＰＺＴ薄膜は、チタン結晶性薄膜３により基板から剥離することなく白金の優れた配向性を受継いだ優れた結晶構造を有する。



【特許請求の範囲】

【請求項１】半導体装置の製造における結晶性薄膜の製造方法であって、

配向性に優れた結晶構造を有する第一膜を成膜した後、成長速度の早い成膜条件で第二膜を形成することを特徴とする結晶性薄膜製造方法。

【請求項２】請求項１の結晶性薄膜製造方法において、第一膜と第二膜とが同一組成の膜であることを特徴とする結晶性薄膜製造方法。

【請求項３】請求項１の結晶性薄膜製造方法において、第一膜が白金膜であることを特徴とする結晶性薄膜製造方法。

【請求項４】半導体装置の製造における結晶性薄膜の製造方法であって、

配向性に優れた分離した状態の種結晶を成長させた後、成長速度の早い成膜条件で希望とする成膜を形成することを特徴とする結晶性薄膜製造方法。

【請求項５】請求項４の結晶性薄膜製造方法において、前記種結晶と希望の薄膜とが同一組成であることを特徴とする結晶性薄膜製造方法。

【請求項６】請求項４の結晶性薄膜製造方法において、前記種結晶が白金膜であることを特徴とする結晶性薄膜製造方法。

【請求項７】半導体装置の製造における結晶性薄膜の製造方法であって、

準備された基板上面に配向性に優れたチタン結晶体を形成した後に、成長速度の早い成膜条件でチタン結晶を成長させ、希望膜厚のチタン成膜を形成する工程と、

前記チタン薄膜上面に白金薄膜を形成する工程と、

前記白金薄膜上面に強誘電体薄膜を成長させる工程と、

を備えたことを特徴とする結晶性薄膜製造方法。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、結晶性薄膜の製造方法に関し、特に成長速度の速い場合の配向性の向上に関する。

【０００２】

【従来の技術】様々な結晶性薄膜が、半導体装置に利用されている。これらの薄膜においては、一般に配向性に優れた結晶構造が要求される。

【０００３】例えば、結晶性薄膜の製造方法として、不揮発性半導体記憶装置（特に強誘電体不揮発性記憶装置）のメモリセルのゲート上に積層される多数の結晶性薄膜の製造方法について説明する。強誘電体不揮発性記憶装置は、強誘電体薄膜が有する残留分極性と分極反転性を記憶手段に利用したものである。なお、残留分極性とは、膜の性質の一つであり、その膜に対して電界を印加した場合に膜が分極し、この分極が電界を取り除いても残留するという性質をいう。また、分極反転性も膜の性質の一つであり、膜を分極させる為に印加した電界とは反対方向の電界を印加することにより膜の分極状態が逆方向に変るという性質をいう。

【０００４】強誘電体不揮発性記憶装置のメモリセルの構造を図４に示す。ソース２５及びドレイン２７の設けられた基板２９のゲート上にチタン薄膜３１、白金薄膜３３、強誘電性（ＰＺＴ等）の薄膜３５及び制御電極３７がこの順に積層されている。

【０００５】上記各薄膜の製造方法について、メモリセルの製造工程の流れに即して以下に説明する。図５にメモリセルの製造工程を断面構成図で示す。

【０００６】図５のＡに示すように、素子分離工程が施されたＰ形シリコン基板２９上面に、電子ビーム蒸着法によりチタンのＣ軸配向性＜００１＞の結晶性薄膜３１を形成する。この場合、電子ビーム蒸着法は以下の条件で行うとよい。温度は300～500℃、電子銃パワーは180～300ワットとする。なお、この工程において前記の条件でチタン結晶を成長させた場合には希望の膜厚（５０ｎｍ程度）のチタン薄膜３１を形成するのに十数分を要する。

【０００７】次に、図５Ｂに示すように、ＣＶＤ法によりチタン薄膜３１の上面に白金薄膜３３を形成する。次に、ゾル-ゲル法により白金薄膜３３の上面に強誘電体薄膜であるＰＺＴ薄膜３５を膜厚５０ｎｍ程度形成する。このゾル-ゲル法では、まず、ゾル溶液の調整を行う。次に、スピンコート法により調整済のゾル溶液を塗布し、乾燥する。次に、酸素雰囲気中７００℃、２０秒の条件で焼結させる。上記の様な塗布・乾燥・焼結工程を複数回繰り返すことにより希望膜厚を得るようにしている。

【０００８】なお、チタン薄膜３１は、基板２９と白金薄膜３３との剥離を防止する為に設けられている。また、白金結晶というのは優先配向性を有する。優先配向性というのは、下地の結晶性にかかわらず配向性を有した結晶が成長する性質をいう。従って、白金膜は下地の結晶性にかかわらず配向性に優れた結晶を有する。しかし、白金薄膜３３は、上述のように配向性に優れたチタン薄膜３１を基板２９上面に形成した後白金薄膜を形成するようにしているから、さらに配向性に優れた白金薄膜３３を形成することが出来る。従って、上述のようにこの配向性に優れた白金薄膜３３を下地として利用することにより、結晶性に優れた強誘電体薄膜３５を形成することが出来た。

【０００９】なお、次に、図６に示すように強誘電体薄膜３５の上面に制御電極３７を形成した後、レジストをマスクにしてエッチングすることにより結晶性チタン薄膜３１、白金薄膜３３、ＰＺＴ薄膜３５、制御電極３７を成形する。次に、制御電極３７をマスクとして、ヒ素またはリンをイオン注入および熱拡散させて、n^+形ソース層２５及びn^+形ドレイン層２７を形成する。

【００１０】以上のようにして形成されたメモリセル１

では、基板２９と制御電極３７間に電界ＶＰを印加することにより、強誘電体薄膜は電界ＶＰ方向に分極し、電界ＶＰを取り除いても分極は残留する。一方、電界ＶＰとは反対方向の電界ＶＱを基板２９・制御電極３７間に印加することにより、強誘電体薄膜の分極は、電界ＶＱ方向に反転し、電界ＶＱを取り除いても分極は残留する。

【００１１】従って、メモリセル１は、強誘電体薄膜の上記のような残留分極及び分極反転の性質を利用することにより、情報を記憶することが出来る。

【００１２】

【発明が解決しようとする課題】しかしながら、従来の結晶性薄膜製造方法には次のような問題点があった。

【００１３】上記の様に、配向性に優れたチタン薄膜３１及び白金薄膜３３及びＰＺＴ薄膜３５等を製造するには、特定の成膜条件で結晶を成長させる必要があった。一般に、配向性に優れた結晶を成長させることの出来る特定の成膜条件では、成長速度が遅かった。

【００１４】従って、配向性に優れた薄膜を得る為には、結晶の成長速度の遅いことから、かなりの時間を要していた。特に、膜厚が厚い場合には問題となっていた。

【００１５】よって、本発明は、上記の問題を解決し、形成時間を短縮したにもかかわらず配向性に優れた結晶構造を有する薄膜を形成する方法を提供することである。

【００１６】

【課題を解決するための手段】請求項１に係る結晶性薄膜の製造方法は、配向性に優れた結晶構造を有する第一膜を成膜した後、成長速度の早い成膜条件で第二膜を形成することを特徴としている。

【００１７】請求項２に係る結晶性薄膜製造方法は、第一膜と第二膜とが同一組成の膜であることを特徴としている。

【００１８】請求項３に係る結晶性薄膜製造方法は、第一膜が白金膜であることを特徴としている。

【００１９】請求項４に係る結晶性薄膜の製造方法は、配向性に優れた分離した状態の種結晶を成長させた後、成長速度の早い成膜条件で希望とする成膜を形成することを特徴としている。

【００２０】請求項５に係る結晶性薄膜製造方法は、前記種結晶と希望の薄膜とが同一組成であることを特徴としている。

【００２１】請求項６に係る結晶性薄膜製造方法は、前記種結晶が白金膜であることを特徴としている。

【００２２】請求項７に係る結晶性薄膜製造方法は、準備された基板上面に配向性に優れたチタン結晶体を形成した後に、成長速度の早い成膜条件でチタン結晶を成長させ、希望膜厚のチタン成膜を形成する工程と、前記チタン薄膜上面に白金薄膜を形成する工程と、前記白金薄膜上面に強誘電体薄膜を成長させる工程とを備えたことを特徴としている。

【００２３】

【作用】請求項１及び請求項２及び請求項３に係る結晶性薄膜製造方法では、配向性に優れた第一膜を形成した後に、第一膜上面に成長速度の早い成膜条件で結晶を成長させるようにしている。

【００２４】従って、第一膜は配向性に優れた下地として働き、成長速度の早い成膜条件でも配向性に優れた第二膜を成長させることが出来る。

【００２５】請求項４及び請求項５及び請求項６に係る結晶性薄膜の製造方法では、配向性に優れた分離した状態の種結晶を成長させた後に、前記種結晶の上に成長速度の早い成膜条件で結晶を成長させるようにしている。

【００２６】従って、前記種結晶は配向性に優れた下地として働き、成長速度の早い成膜条件でも配向性に優れた第二膜を成長させることが出来る。

【００２７】請求項７に係る結晶性薄膜の製造方法では、準備された基板上面に配向性に優れたチタン結晶体を形成した後に、成長速度の早い成膜条件でチタン結晶を成長させ、希望膜厚のチタン成膜を形成するようにしている。

【００２８】従って、前記チタン結晶体は配向性に優れた下地として働き、成長速度の早い成膜条件でも配向性に優れたチタン成膜を成長させることが出来る。

【００２９】また、前記チタン薄膜上面に白金薄膜を形成するようにしている。

【００３０】従って、白金は元来優先配向性を有しているが、前記チタン薄膜が配向性に優れた下地として働くことによりさらに配向性に優れた白金薄膜を成長させることが出来る。また、前記チタン薄膜は、前記基板および前記白金薄膜のどちらにも密着性を有する。

【００３１】前記白金薄膜上面に強誘電体薄膜を成長させるようにしている。

【００３２】従って、さらに配向性に優れた前記白金薄膜が下地として働くことにより、配向性に優れた強誘電体薄膜を成長させることが出来る。

【００３３】

【実施例】本発明に係る結晶性薄膜製造方法を用いた一実施例として強誘電体不揮発性記憶装置のメモリセル１のゲート上に積層される結晶性薄膜の製造方法について、メモリセル１の製造工程に即して以下に説明する。図１Ａ、Ｂ、Ｃ及び図２Ａ、Ｂ及び図３に製造工程を断面構成図で示す。

【００３４】図１Ａに示すようにメモリセル１を形成する為に、まずシリコンウエーハ５が準備される。

【００３５】次に、図１Ｂ及びＣに示すように、シリコンウエーハ５の上面に電子ビーム蒸着法によりＣ軸配向性<００１>のチタン結晶性薄膜３を形成する。この場合、電子ビーム蒸着法は以下の様に異なった条件で２工

程に分けて行う。初めの第一工程では、温度を300℃から400℃、例えば350℃とし、電子銃パワーを180～300ワットに設定し、第一膜として膜厚が数ｎｍ程度になるまでチタン結晶体７を成長させる。次の第二工程では、温度を500℃から600℃、例えば550℃とし、電子銃パワーを180～300ワットに設定し、第二膜としてチタン結晶性薄膜９を成長させ、希望膜厚（５０ｎｍ程度）のチタン結晶性薄膜３を得る。

【００３６】なお、第一工程の温度条件（350℃）によるチタン結晶の成長では、配向性に優れたＣ軸配向性＜００１＞のチタン結晶を成長させることは出来るが、成長速度が遅い。また、第二工程の温度条件（550℃）でチタン結晶を成長させた場合、成長速度は早いが普通＜０１１＞配向のチタン結晶が成長する。しかしながら、この実施例においては第一工程に続いて第二工程を行うことにより、第二工程の温度条件でもＣ軸配向性＜００１＞のチタン結晶を早い成長速度のままで成長させることが出来る。従って、シリコンウエーハ５の上面に数分で配向性に優れたＣ軸配向＜００１＞のチタン結晶性薄膜３（膜厚５０ｎｍ程度）を形成することが出来る。

【００３７】なお、この実施例ではチタン結晶体７は第一膜として膜厚数ｎｍ程度に成膜しているが、その代りに配向性に優れた分離した状態の種結晶を形成するだけでもよい。この場合も、＜０１１＞配向の結晶が成長する成膜条件にもかかわらず、その上面には配向性に優れたＣ軸配向性＜００１＞のチタン結晶性薄膜を形成することが出来る。

【００３８】また、この実施例においては、第一膜または種結晶の上に組成が同じである第二膜を成長させているが、第二膜として異なった組成の結晶を成長させることも出来る。

【００３９】次に、図２Ａに示すように、チタン結晶性薄膜３の上面にＣＶＤ法により＜１１１＞配向の白金薄膜１１を形成する。なお、白金は元来下地にかかわらず優先配向することにより配向性に優れた結晶が成長する。しかしこの実施例においては、＜１１１＞配向を有する白金の格子間距離に近いＣ軸配向性＜００１＞のチタン結晶性薄膜３を下地として設けた後に白金を成長させているから、成長した白金の結晶はさらに良好な配向性を示す。

【００４０】また、この時チタン薄膜３をシリコンウエーハ５と白金薄膜１１との間に設けたことにより、シリコンウエーハ５からの白金薄層１１の剥離を防ぐことができる。

【００４１】次に、図２Ａに示すように、ゾル・ゲル法により強誘電体薄膜であるＰＺＴ薄膜１３が白金薄膜１１上面に形成される。ここで、このゾル・ゲル法によるＰＺＴ薄膜の形成方法は、以下の様に行われる。

【００４２】まず、ゾル溶液の調整を行う。ゾル溶液は、ＰＺＴをPb：Zr：Ti＝１：0.58：0.48のモル比に調整される。

【００４３】次に、スピンコート法により3000rpmの条件下で調整済のゾル溶液を塗布し、１００℃、１５分の条件で乾燥した後、ＲＴＡ（Rapid Thermal Anneeling）の装置を使用し、酸素雰囲気中７５０℃、２０秒の条件で焼結させ、膜厚５０ｎｍ程度のＰＺＴ薄膜１３を形成する。

【００４４】上述の様に、この実施例においては第一膜として白金薄膜１１を設けた後に第二膜として結晶性薄膜であるＰＺＴ薄膜１３を形成するようにしている。従って、白金薄膜１１の良好な配向性を受継いだＰＺＴ薄膜１３を形成することが出来る。

【００４５】なお、白金薄膜の代りに配向性に優れた分離した状態の白金種結晶を形成するだけでもよい。この場合もこの白金種結晶の配向性を受継いだＰＺＴ薄膜を形成することが出来る。また、この白金結晶のように素子の機能に直接関係しない場合は、不必要な成分は出きるだけ少なくするという意味で成膜せずに分離した状態の種結晶を用いた方がよい。

【００４６】さらに、マグネトロンスパッタリング法（温度条件６１０℃）によりＰＺＴ薄膜１３上面にＰＺＴ薄膜１５を成長させ合せて膜厚２００ｎｍのＰＺＴ薄膜１７を形成する。

【００４７】上述の様に、この実施例においてはＰＺＴ薄膜１７を二回の工程に分けて（別の方法で）形成している。初めのゾル・ゲル法により白金薄膜の配向性を受継いだ配向性に優れたＰＺＴ薄膜を第一膜として形成した後に、スパッタリング法を用いて第二膜としてＰＺＴ結晶を成長させ、ＰＺＴ薄膜１７の膜厚を２００ｎｍとしている。

【００４８】なお、次に、ＰＺＴ薄膜１７上面にスパッタリング法により白金薄膜１９を堆積させた後、レジストをマスクにしてエッチングすることにより結晶性チタン薄膜８、白金薄膜１１、ＰＺＴ薄膜１７、白金薄膜１９を成形する。次に、白金薄膜１９をマスクにして、ヒ素またはリンをイオン注入および熱拡散させて、n^+形ドレイン層２１およびn^+形ソース層２３を形成する。以上のようにしてメモリセルが形成される。

【００４９】

【発明の効果】請求項１及び請求項２及び請求項３に係る結晶性薄膜製造方法では、配向性に優れた第一膜を形成した後に、第一膜上面に成長速度の早い成膜条件で結晶を成長させるようにしている。よって第一膜は配向性に優れた下地として働き、成長速度の早い成膜条件でも配向性に優れた第二膜を成長させることが出来る。

【００５０】従って、配向性に優れた結晶構造を有する薄膜を短時間で形成することができる。

【００５１】請求項４及び請求項５及び請求項６に係る結晶性薄膜の製造方法では、配向性に優れた分離した状態の種結晶を成長させた後に、前記種結晶の上に成長速

度の早い成膜条件で結晶を成長させるようにしている。よって前記種結晶は配向性に優れた下地として働き、成長速度の早い成膜条件でも配向性に優れた第二膜を成長させることが出来る。

【００５２】従って、配向性に優れた結晶構造を有する薄膜を短時間で形成することができる。

【００５３】請求項７に係る結晶性薄膜の製造方法では、基板上面に配向性に優れたチタン結晶体を形成した後に、成長速度の早い成膜条件でチタン結晶を成長させ、希望膜厚のチタン成膜を形成するようにしている。よって前記チタン結晶体は配向性に優れた下地として働き、成長速度の早い成膜条件でも配向性に優れたチタン成膜を成長させることが出来る。

【００５４】従って、配向性に優れた希望膜厚のチタン成膜を短時間で形成することが出来る。

【００５５】また、前記チタン薄膜上面に白金薄膜を形成するようにしている。

【００５６】従って、白金は元来優先配向性を有しているが、前記チタン薄膜が配向性に優れた下地として働くことによりさらに配向性に優れた白金薄膜を形成することが出来る。また、前記チタン薄膜は前記基板および前記白金薄膜のどちらにも密着性があるから、前記基板と前記白金薄膜の剥離を防ぐことが出来る。

【００５７】また、前記白金薄膜上面に強誘電体薄膜を成長させるようにしている。＊

＊【００５８】従って、配向性に優れた前記白金薄膜が下地として働くことにより、配向性に優れた強誘電体薄膜を形成することが出来る。

【図面の簡単な説明】

【図１】本発明の一実施例による結晶性薄膜の製造方法を示す為の製造工程図である。

【図２】本発明の一実施例による結晶性薄膜の製造方法を示す為の製造工程図である。

【図３】本発明の一実施例による結晶性薄膜を示す為の製造工程図である。

【図４】従来の結晶性薄膜を示す為の製造工程図である。

【図５】従来の結晶性薄膜を示す為の製造工程図である。

【図６】従来の結晶性薄膜を示す為の製造工程図である。

【符号の説明】

７・・・チタン結晶体

９・・・チタン結晶性薄膜

３・・・チタン結晶性薄膜

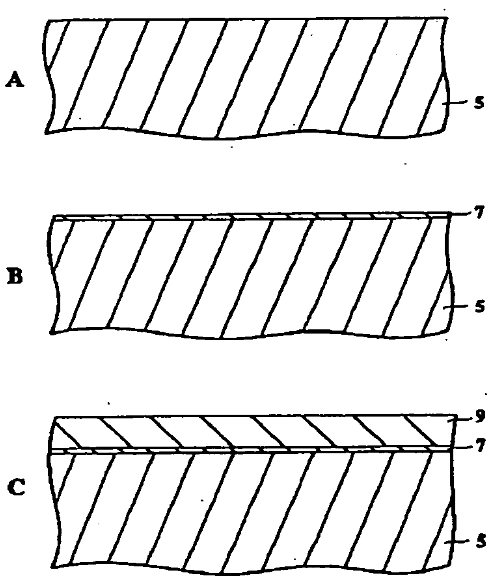
１１・・・白金薄膜

１３・・・ＰＺＴ薄膜

１５・・・ＰＺＴ薄膜

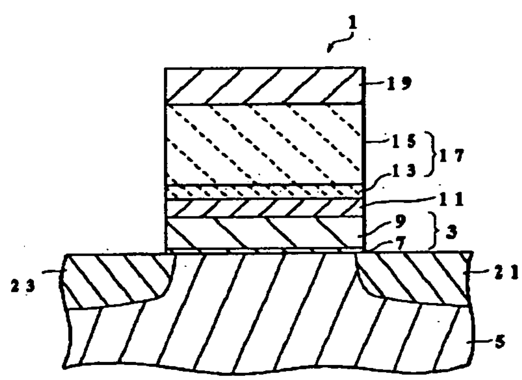
１７・・・ＰＺＴ薄膜

【図１】

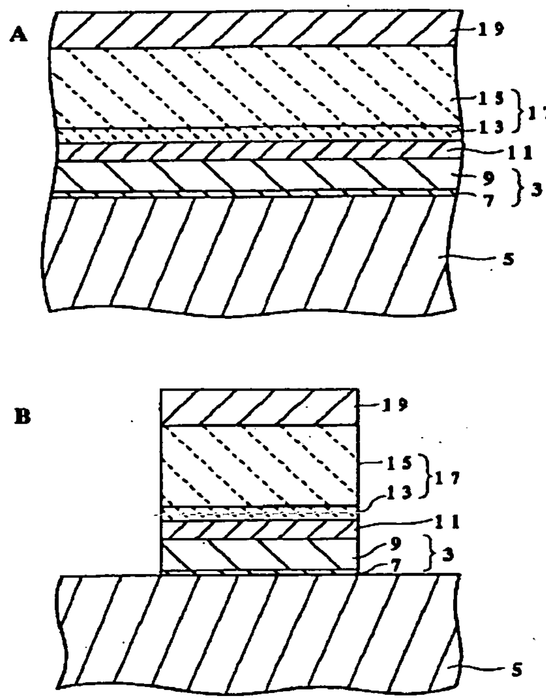


3：チタン結晶性薄膜
5：シリコンウェーハ
7：チタン結晶体
9：チタン結晶性薄膜

【図３】

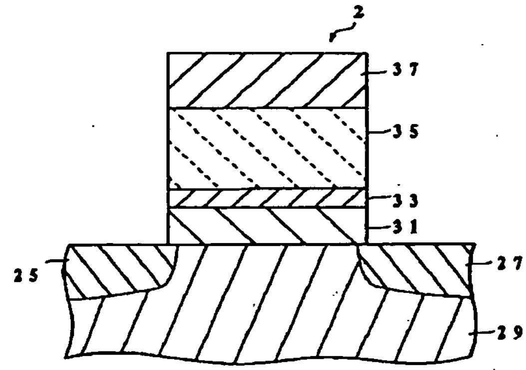


【図2】

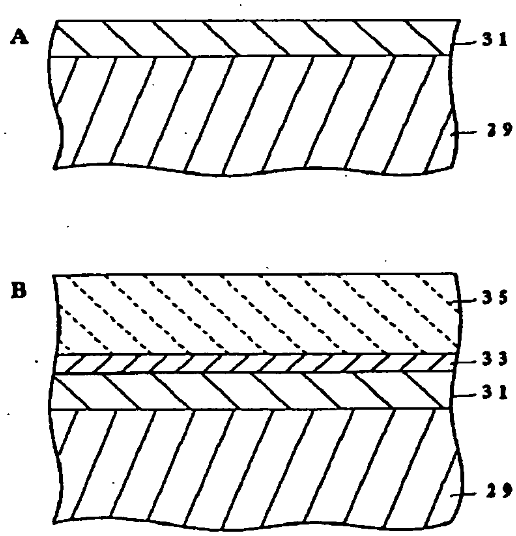


１１：白金薄膜　１５：ＰＺＴ薄膜
１３：ＰＺＴ薄膜　１７：ＰＺＴ薄膜

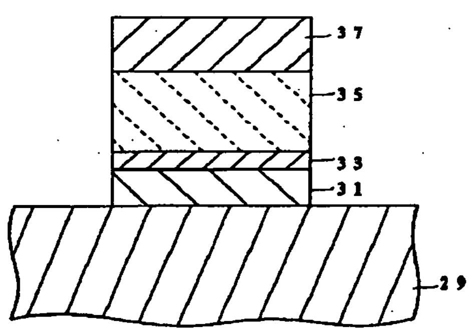
【図4】



【図5】



【図6】



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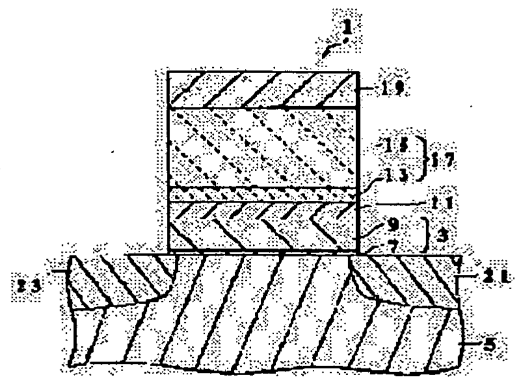
(72)Inventor : SAMEJIMA KATSUMI

(54) MANUFACTURE OF CRYSTALLINE THIN FILM

(57)Abstract:
PURPOSE: To provide a method of forming a thin film having a crystal structure, which is superior in orientation property, in a short time.
CONSTITUTION: A titanium crystal substance 7 having a superior orientation property is formed on the upper surface of a substrate 5 and thereafter, after a titanium crystalline thin film 9 is grown on the film formation condition of a quick growth rate, a titanium crystalline thin film 3 which maintains the superior orientation property of the crystal substance 7 can be formed in a short time. A platinum thin film 11 and a PZT thin film 17 are formed on the upper surface of the thin film 3 in the order of these thin films 11 and 17. At this time, the thin film 17 has a superior crystal structure inheriting the superior orientation property of platinum without being peeled from the substrate by the thin film 3.



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CLAIMS

[Claim(s)]
[Claim 1] The crystalline thin-film-fabrication method which is the manufacture method of the crystalline thin film in manufacture of a semiconductor device, and is characterized by forming the second film on the early membrane formation conditions of a growth rate after forming the first film which has the crystal structure excellent in the stacking tendency.
[Claim 2] The crystalline thin-film-fabrication method characterized by the first film and the second film being films of the same composition in the crystalline thin-film-fabrication method of a claim 1.
[Claim 3] The crystalline thin-film-fabrication method characterized by the first film being a platinum film in the crystalline thin-film-fabrication method of a claim 1.
[Claim 4] The crystalline thin-film-fabrication method which is the manufacture method of the crystalline thin film in manufacture of a semiconductor device, and is characterized by forming the membrane formation considered as hope on the early membrane formation conditions of a growth rate after growing up the seed crystal excellent in the stacking tendency in the state where it dissociated.
[Claim 5] The crystalline thin-film-fabrication method characterized by the aforementioned seed crystal and the thin film of hope being the same composition in the crystalline thin-film-fabrication method of a claim 4.
[Claim 6] The crystalline thin-film-fabrication method characterized by the aforementioned seed crystal being a platinum film in the crystalline thin-film-fabrication method of a claim 4.
[Claim 7] The manufacture method of the crystalline thin film in manufacture of a semiconductor device characterized by providing the following. The process which a titanium crystal is grown up on the early membrane formation conditions of a growth rate, and forms titanium membrane formation of the thickness of choice after forming the titanium crystalline excellent in the stacking tendency in the prepared substrate upper surface. The process which forms a platinum thin film in the aforementioned titanium thin film upper surface, and the process which grows up a ferroelectric thin film into the aforementioned platinum thin film upper surface.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] this invention relates to improvement in the stacking tendency in the case of being quick of especially a growth rate about the manufacture method of a crystalline thin film.
[0002]
[Description of the Prior Art] Various crystalline thin films are used for the semiconductor device. In these thin films, the crystal structure which was generally excellent in the stacking tendency is required.
[0003] For example, the manufacture method of the crystalline thin film of a large number by which a laminating is carried out on the gate of the memory cell of a nonvolatile semiconductor memory (especially ferroelectric nonvolatile storage) is explained as the manufacture method of a crystalline thin film. A ferroelectric nonvolatile storage uses for a storage means the remanence nature and polarization parity which a ferroelectric thin film has. In addition, remanence nature is one of the membranous properties, and means the property to remain even if a film polarizes and this polarization removes electric field, when electric field are impressed to the film. Moreover, polarization parity is also one of the membranous properties, and the electric field impressed in order to carry out polarization of the film mean the property in which a membranous polarization state changes to an opposite direction, by impressing the electric field of opposite direction.
[0004] The structure of the memory cell of a ferroelectric nonvolatile storage is shown in drawing 4 . The laminating of the titanium thin film 31, the platinum thin film 33, the thin film 35 of ferroelectricities (PZT etc.), and the control electrode 37 is carried out to this order on the gate of a substrate 29 in which the source 25 and the drain 27 were formed.
[0005] It is based on the flow of the manufacturing process of a memory cell, and the manufacture method of each above-mentioned thin film is explained below. A cross-section block diagram shows the manufacturing process of a memory cell to drawing 5 .
[0006] As shown in A of drawing 5 , the crystalline thin film 31 of C shaft stacking tendency <001> of titanium is formed in the P type silicon-substrate 29 upper surface where the isolation process was given by the electron-beam-evaporation method. In this case, as for an electron-beam-evaporation method, it is good to carry out on condition that the following. 300-500 degrees C and electron gun power make temperature 180-300W. In addition, when growing up a titanium crystal on condition that the above in this process, about ten minutes is taken to form the titanium thin film 31 of the thickness (about 50nm) of hope.
[0007] Next, as shown in drawing 5 B, the platinum thin film 33 is formed in the upper surface of the titanium thin film 31 by CVD. Next, the PZT thin film 35 which is a ferroelectric thin film is formed in the upper surface of the platinum thin film 33 about 50nm of thickness with a sol-gel method. In this sol-gel method, a sol solution is adjusted first. Next, an adjusted sol solution is applied by the spin coat method, and it dries. Next, it is made to sinter on 700 degrees C and the conditions for 20 seconds among oxygen atmosphere. It is made to obtain the thickness of choice by repeating the above application and dryness / sintering processes two or more times.
[0008] In addition, the titanium thin film 31 is formed in order to prevent ablation with a substrate 29 and the platinum thin film 33. Moreover, a platinum crystal has a priority stacking tendency. A priority stacking tendency says the property in which a crystal with the stacking tendency grows, irrespective of the crystallinity of a ground. Therefore, a platinum film has the crystal excellent in the stacking tendency irrespective of the crystallinity of a ground. However, since it is made to form a platinum thin film after the platinum thin film 33 forms in the substrate 29 upper surface the titanium thin film 31 which was excellent in the stacking tendency as mentioned above, it can form the platinum thin film 33 which was further excellent in the stacking tendency. Therefore, the ferroelectric thin film 35 excellent in crystallinity was able to be formed by using as a ground the platinum thin film 33 which was excellent in this stacking tendency as mentioned above.
[0009] In addition, next, as shown in drawing 6 , after forming a control electrode 37 in the upper surface of the ferroelectric thin film 35, the crystalline titanium thin film 31, the platinum thin film 33, the PZT thin film 35, and a control electrode 37 are fabricated by using a resist as a mask and **********ing. next, the control electrode 37 — a mask — carrying out — an arsenic or Lynn — an ion implantation — and thermal diffusion is carried out and n+ type source layer 25 and n+ type drain layer 27 are formed
[0010] In the memory cell 1 formed as mentioned above, by impressing electric field VP between a substrate 29 and a control electrode 37, a ferroelectric thin film is polarized in the electric-field VP direction, and even if it removes electric field VP, polarization remains. On the other hand, in electric field VP, by impressing the electric field VQ of opposite dir ction between substrate 29 and a control electrod 37, polarization of a ferroelectric thin film is reversed in the el ctric-field VQ direction, and even if it removes lectric field VQ, polarization remains.
[0011] Therefore, a memory cell 1 can memorize information by using the above remanences of a ferroelectric thin film.

and the property of polarization reversal.
[0012]
[Problem(s) to be Solved by the Invention] However, there were the following troubles in the conventional crystalline thin-film-fabrication method.
[0013] As mentioned above, in order to manufacture the titanium thin film 31, the platinum thin film 33, and PZT thin film 35 grade excellent in the stacking tendency, the crystal needed to be grown up on specific membrane formation conditions. On the specific membrane formation conditions that the crystal excellent in the stacking tendency can generally be grown up, the growth rate was slow.
[0014] Therefore, in order to obtain the thin film excellent in the stacking tendency, most time was required from crystal-growth speed being slow. Especially, it had become a problem when thickness was thick.
[0015] Therefore, although this invention solved the above-mentioned problem and shortened formation time, it is offering the method of forming the thin film which has the crystal structure excellent in the stacking tendency.
[0016]
[Means for Solving the Problem] After the manufacture method of the crystalline thin film concerning a claim 1 forms the first film which has the crystal structure excellent in the stacking tendency, it is characterized by forming the second film on the early membrane formation conditions of a growth rate.
[0017] The crystalline thin-film-fabrication method concerning a claim 2 is characterized by the first film and the second film being films of the same composition.
[0018] The crystalline thin-film-fabrication method concerning a claim 3 is characterized by the first film being a platinum film.
[0019] After the manufacture method of the crystalline thin film concerning a claim 4 grows up the seed crystal excellent in the stacking tendency in the state where it dissociated, it is characterized by forming the membrane formation considered as hope on the early membrane formation conditions of a growth rate.
[0020] The crystalline thin-film-fabrication method concerning a claim 5 is characterized by the aforementioned seed crystal and the thin film of hope being the same composition.
[0021] The crystalline thin-film-fabrication method concerning a claim 6 is characterized by the aforementioned seed crystal being a platinum film.
[0022] After the crystalline thin-film-fabrication method concerning a claim 7 forms the titanium crystalline excellent in the stacking tendency in the prepared substrate upper surface, it grows up a titanium crystal on the early membrane-formation conditions of a growth rate, and is characterized by to have the process which forms titanium membrane formation of the thickness of choice, the process which forms a platinum thin film in the aforementioned titanium thin film upper surface, and the process which grows up a ferroelectric thin film into the aforementioned platinum thin film upper surface.
[0023]
[Function] After forming the first film excellent in the stacking tendency, it is made to grow up a crystal into the first film upper surface on the early membrane formation conditions of a growth rate by the crystalline thin-film-fabrication method concerning a claim 1, a claim 2, and a claim 3.
[0024] Therefore, the first film can be committed as a ground excellent in the stacking tendency, and the second film which was excellent also in the early membrane formation conditions of a growth rate at the stacking tendency can be grown up.
[0025] After growing up the seed crystal excellent in the stacking tendency in the state where it dissociated, it is made to grow up a crystal on the early membrane formation conditions of a growth rate on the aforementioned seed crystal by the manufacture method of the crystalline thin film concerning a claim 4, a claim 5, and a claim 6.
[0026] Therefore, the aforementioned seed crystal can be committed as a ground excellent in the stacking tendency, and can grow up the second film which was excellent also in the early membrane formation conditions of a growth rate at the stacking tendency.
[0027] After forming the titanium crystalline excellent in the stacking tendency in the prepared substrate upper surface, a titanium crystal is grown up on the early membrane formation conditions of a growth rate, and it is made to form titanium membrane formation of the thickness of choice by the manufacture method of the crystalline thin film concerning a claim 7.
[0028] Therefore, the aforementioned titanium crystalline can be committed as a ground excellent in the stacking tendency, and can grow up the titanium membrane formation which was excellent also in the early membrane formation conditions of a growth rate at the stacking tendency.
[0029] Moreover, it is made to form a platinum thin film in the aforementioned titanium thin film upper surface.
[0030] Therefore, although platinum has the priority stacking tendency originally, the platinum thin film which was further excellent in the stacking tendency can be grown up by working as a ground the aforementioned titanium thin film excelled [ground] in the stacking tendency. Moreover, the aforementioned titanium thin film has adhesion in both the aforementioned substrate and the aforementioned platinum thin film.
[0031] It is made to grow up a ferroelectric thin film into the aforementioned platinum thin film upper surface.
[0032] Therefore, when the aforementioned platinum thin film which was further excellent in the stacking tendency works as a ground, the ferroelectric thin film excellent in the stacking tendency can be grown up.
[0033]
[Example] It is based on the manufacturing process of a memory cell 1, and the manufacture method of the crystalline thin film by which a laminating is carried out on the gate of the memory cell 1 of a ferroelectric nonvolatile storage as one

example using the crystalline thin-film-fabrication method concerning this invention is explained below. A cross-section block diagram shows a manufacturing process to drawing 1 A, B, and C, drawing 2 A and B, and drawing 3 .
[0034] As shown in drawing 1 A, in order to form a memory cell 1, a silicon wafer 5 is prepared first.
[0035] Next, as shown in drawing 1 B and C, the titanium crystallinity thin film 3 of C shaft stacking tendency <001> is formed in the upper surface of a silicon wafer 5 by the electron-beam-evaporation method. In this case, on different conditions as follows, an electron-beam-evaporation method is divided into two processes, and is performed. At the first first process, temperature is made into 300 degrees C to 400 degrees C, for example, 350 degrees C, electron gun power is set as 180-300W, and the titanium crystalline 7 is grown up until thickness is set to about several nm as the first film. At the second following process, temperature is made into 500 degrees C to 600 degrees C, for example, 550 degrees C, electron gun power is set as 180-300W, the titanium crystallinity thin film 9 is grown up as the second film, and the titanium crystallinity thin film 3 of the thickness (about 50nm) of choice is obtained.
[0036] In addition, a growth rate is slow although the titanium crystal of C shaft stacking tendency <001> excellent in the stacking tendency can be grown up in the titanium crystal growth by the temperature conditions (350 degrees C) of the first process. Moreover, when growing up a titanium crystal on the temperature conditions (550 degrees C) of the second process, although a growth rate is early, the titanium crystal of <011> orientation usually grows. However, the titanium crystal of C shaft stacking tendency <001> can be grown up also on the temperature conditions of the second process by performing the second process following the first process in this example with an early growth rate. Therefore, the titanium crystallinity thin film 3 (about 50nm of thickness) of C shaft orientation <001> which was excellent in several minutes at the stacking tendency can be formed in the upper surface of a silicon wafer 5.
[0037] In addition, it is also good to form the seed crystal excellent in the stacking tendency in the state where it dissociated, in this example, although the titanium crystalline 7 is forming membranes to about several nm thickness as the first film instead. The titanium crystallinity thin film of C shaft stacking tendency <001> excellent in the stacking tendency can be formed in the upper surface in spite of the membrane formation conditions the crystal of <011> orientation grows up to be also in this case.
[0038] Moreover, in this example, although composition is growing up the second same film on the first film or seed crystal, the crystal of different composition as the second film can also be grown up.
[0039] Next, as shown in drawing 2 A, the platinum thin film 11 of <111> orientation is formed in the upper surface of the titanium crystallinity thin film 3 by CVD. In addition, the crystal excellent in the stacking tendency grows by carrying out priority orientation of the platinum irrespective of a ground originally. However, in this example, since platinum is grown up after forming as a ground the titanium crystallinity thin film 3 of C shaft stacking tendency <001> near the distance between grids of the platinum which has <111> orientation, the grown-up crystal of platinum shows a still better stacking tendency.
[0040] Moreover, ablation of the platinum thin layer 11 from a silicon wafer 5 can be prevented by having formed the titanium thin film 3 between the silicon wafer 5 and the platinum thin film 11 at this time.
[0041] Next, as shown in drawing 2 A, the PZT thin film 13 which is a ferroelectric thin film is formed in the platinum thin film 11 upper surface by the sol-gel method. Here, the formation method of the PZT thin film by this sol-gel method is performed as follows.
[0042] First, a sol solution is adjusted. A sol solution is adjusted to the mole ratio of Pb:Zr:Ti=1:0.58:0.48 in PZT.
[0043] Next, after applying a sol solution adjusted in the bottom of the conditions of 3000rpm by the spin coat method and drying on 100 degrees C and the conditions for 15 minutes, use the equipment of RTA (Rapid Thermal Anneeling), it is made to sinter on 750 degrees C and the conditions for 20 seconds among oxygen atmosphere, and the PZT thin film 13 of about 50nm of thickness is formed.
[0044] As mentioned above, after forming the platinum thin film 11 as the first film in this example, it is made to form the PZT thin film 13 which is a crystalline thin film as the second film. Therefore, the PZT thin film 13 which inherited the good stacking tendency of the platinum thin film 11 can be formed.
[0045] In addition, it is also good to form the platinum seed crystal in the state where it dissociated which was excellent in the stacking tendency instead of the platinum thin film. The PZT thin film which inherited the stacking tendency of this platinum seed crystal also in this case can be formed. Moreover, it is better to use the seed crystal in the state where it dissociated without forming membranes in the meaning of lessening as the unnecessary component has come out, when not directly related to the function of an element like this platinum crystal.
[0046] Furthermore, the PZT thin film 15 is grown up into the PZT thin film 13 upper surface by the magnetron sputtering method (610 degrees C of temperature conditions), and the PZT thin film 17 of 200nm of thickness is formed.
[0047] As mentioned above, in this example, the PZT thin film 17 is divided into the process of two times, and is formed (with option). After forming the PZT thin film excellent in the stacking tendency which inherited the stacking tendency of a platinum thin film with the first sol-gel method as the first film, the sputtering method is used, a PZT crystal is grown up as the second film, and thickness of the PZT thin film 17 is set to 200nm.
[0048] In addition, next, after making the platinum thin film 19 deposit on the PZT thin film 17 upper surface by the sputtering method, the crystalline titanium thin film 8, the platinum thin film 11, the PZT thin film 17, and the platinum thin film 19 are fabricated by using a resist as a mask and **********ing. next, the platinum thin film 19 — a mask — carrying out — an arsenic or Lynn — an ion implantation — and thermal diffusion is carried out and n+ type drain layer 21 and n+ type sourc layer 23 are formed. A memory cell is formed as mentioned abov .
[0049]
[Effect of the Invention] After forming the first film excellent in the stacking tendency, it is mad to grow up a crystal into the first film upper surface on the early membran formation conditions of a growth rate by the crystallin thin-film-

fabrication method concerning a claim 1, a claim 2, and a claim 3. Therefore, the first film can be committed as a ground excellent in the stacking tendency, and the second film which was excellent also in the early membrane formation conditions of a growth rate at the stacking tendency can be grown up.
[0050] Therefore, the thin film which has the crystal structure excellent in the stacking tendency can be formed in a short time.
[0051] After growing up the seed crystal excellent in the stacking tendency in the state where it dissociated, it is made to grow up a crystal on the early membrane formation conditions of a growth rate on the aforementioned seed crystal by the manufacture method of the crystalline thin film concerning a claim 4, a claim 5, and a claim 6. Therefore, the aforementioned seed crystal can be committed as a ground excellent in the stacking tendency, and can grow up the second film which was excellent also in the early membrane formation conditions of a growth rate at the stacking tendency.
[0052] Therefore, the thin film which has the crystal structure excellent in the stacking tendency can be formed in a short time.
[0053] After forming the titanium crystalline excellent in the stacking tendency in the substrate upper surface, a titanium crystal is grown up on the early membrane formation conditions of a growth rate, and it is made to form titanium membrane formation of the thickness of choice by the manufacture method of the crystalline thin film concerning a claim 7. Therefore, the aforementioned titanium crystalline can be committed as a ground excellent in the stacking tendency, and can grow up the titanium membrane formation which was excellent also in the early membrane formation conditions of a growth rate at the stacking tendency.
[0054] Therefore, titanium membrane formation of the thickness of choice excellent in the stacking tendency can be formed in a short time.
[0055] Moreover, it is made to form a platinum thin film in the aforementioned titanium thin film upper surface.
[0056] Therefore, although platinum has the priority stacking tendency originally, it can form the platinum thin film which was further excellent in the stacking tendency by working as a ground the aforementioned titanium thin film excelled [ground] in the stacking tendency. Moreover, since the aforementioned titanium thin film has adhesion in both the aforementioned substrate and the aforementioned platinum thin film, it can prevent exfoliation of the aforementioned substrate and the aforementioned platinum thin film.
[0057] Moreover, it is made to grow up a ferroelectric thin film into the aforementioned platinum thin film upper surface.
[0058] Therefore, when the aforementioned platinum thin film excellent in the stacking tendency works as a ground, the ferroelectric thin film excellent in the stacking tendency can be formed.

[Translation done.]

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TECHNICAL FIELD

[Industrial Application] this invention relates to improvement in the stacking tendency in the case of being quick of especially a growth rate about the manufacture method of a crystalline thin film.

[Translation done.]

PRIOR ART

[Description of the Prior Art] Various crystalline thin films are used for the semiconductor device. In these thin films, the crystal structure which was generally excellent in the stacking tendency is required.
[0003] For example, the manufacture method of the crystalline thin film of a large number by which a laminating is carried out on the gate of the memory cell of a nonvolatile semiconductor memory (especially ferroelectric nonvolatile storage) is explained as the manufacture method of a crystalline thin film. A ferroelectric nonvolatile storage uses for a storage means the remanence nature and polarization parity which a ferroelectric thin film has. In addition, remanence nature is one of the membranous properties, and means the property to remain even if a film polarizes and this polarization removes electric field, when electric field are impressed to the film. Moreover, polarization parity is also one of the membranous properties, and the electric field impressed in order to carry out polarization of the film mean the property in which a membranous polarization state changes to an opposite direction, by impressing the electric field of opposite direction.
[0004] The structure of the memory cell of a ferroelectric nonvolatile storage is shown in drawing 4 . The laminating of the ~~titanium thin film 31, the platinum thin film 33, the thin film 35 of ferroelectricities (PZT etc.)~~, and the control electrode 37 is carried out to this order on the gate of a substrate 29 in which the source 25 and the drain 27 were formed.
[0005] It is based on the flow of the manufacturing process of a memory cell, and the manufacture method of each above-mentioned thin film is explained below. A cross-section block diagram shows the manufacturing process of a memory cell to drawing 5 .
[0006] As shown in A of drawing 5 , the crystalline thin film 31 of C shaft stacking tendency <001> of titanium is formed in the P type silicon-substrate 29 upper surface where the isolation process was given by the electron-beam-evaporation method. In this case, as for an electron-beam-evaporation method, it is good to carry out on condition that the following. 300-500 degrees C and electron gun power make temperature 180-300W. In addition, when growing up a titanium crystal on condition that the above in this process, about ten minutes is taken to form the titanium thin film 31 of the thickness (about 50nm) of hope.
[0007] Next, as shown in drawing 5 B, the platinum thin film 33 is formed in the upper surface of the titanium thin film 31 by CVD. Next, the PZT thin film 35 which is a ferroelectric thin film is formed in the upper surface of the platinum thin film 33 about 50nm of thickness with a sol-gel method. In this sol-gel method, a sol solution is adjusted first. Next, an adjusted sol solution is applied by the spin coat method, and it dries. Next, it is made to sinter on 700 degrees C and the conditions for 20 seconds among oxygen atmosphere. It is made to obtain the thickness of choice by repeating the above application and dryness / sintering processes two or more times.
[0008] In addition, the titanium thin film 31 is formed in order to prevent ablation with a substrate 29 and the platinum thin film 33. Moreover, a platinum crystal has a priority stacking tendency. A priority stacking tendency says the property in which a crystal with the stacking tendency grows, irrespective of the crystallinity of a ground. Therefore, a platinum film has the crystal excellent in the stacking tendency irrespective of the crystallinity of a ground. However, since it is made to form a platinum thin film after the platinum thin film 33 forms in the substrate 29 upper surface the titanium thin film 31 which was excellent in the stacking tendency as mentioned above, it can form the platinum thin film 33 which was further excellent in the stacking tendency. Therefore, the ferroelectric thin film 35 excellent in crystallinity was able to b formed by using as a ground the platinum thin film 33 which was excellent in this stacking tendency as mentioned above.
[0009] In addition, next, as shown in drawing 6 , after forming a control electrode 37 in the upper surface of the ferroelectric thin film 35, the crystalline titanium thin film 31, the platinum thin film 33, the PZT thin film 35, and a control electrode 37 are fabricated by using a resist as a mask and **********ing. next, the control electrode 37 — a mask — carrying out — an arsenic or Lynn — an ion implantation — and thermal diffusion is carried out and n+ type source layer 25 and n+ type drain layer 27 are formed
[0010] In the memory cell 1 formed as mentioned above, by impressing electric field VP between a substrate 29 and a control electrode 37, a ferroelectric thin film is polarized in the electric-field VP direction, and even if it removes electric field VP, polarization remains. On the other hand, in electric field VP, by impressing the electric field VQ of opposite direction between substrate 29 and a control electrode 37, polarization of a ferroelectric thin film is reversed in th electric-field VQ direction, and even if it removes electric field VQ, polarization remains.
[0011] Therefore, a memory cell 1 can memorize information by using the above remanences of a ferroelectric thin film, and the property of polarization reversal.

[Translation done.]

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EFFECT OF THE INVENTION

[Effect of the Invention] After forming the first film excellent in the stacking tendency, it is made to grow up a crystal into the first film upper surface on the early membrane formation conditions of a growth rate by the crystalline thin-film-fabrication method concerning a claim 1, a claim 2, and a claim 3. Therefore, the first film can be committed as a ground excellent in the stacking tendency, and the second film which was excellent also in the early membrane formation conditions of a growth rate at the stacking tendency can be grown up.
[0050] Therefore, the thin film which has the crystal structure excellent in the stacking tendency can be formed in a short time.
[0051] After growing up the seed crystal excellent in the stacking tendency in the state where it dissociated, it is made to grow up a crystal on the early membrane formation conditions of a growth rate on the aforementioned seed crystal by the manufacture method of the crystalline thin film concerning a claim 4, a claim 5, and a claim 6. Therefore, the aforementioned seed crystal can be committed as a ground excellent in the stacking tendency, and can grow up the second film which was excellent also in the early membrane formation conditions of a growth rate at the stacking tendency.
[0052] Therefore, the thin film which has the crystal structure excellent in the stacking tendency can be formed in a short time.
[0053] After forming the titanium crystalline excellent in the stacking tendency in the substrate upper surface, a titanium crystal is grown up on the early membrane formation conditions of a growth rate, and it is made to form titanium membrane formation of the thickness of choice by the manufacture method of the crystalline thin film concerning a claim 7. Therefore, the aforementioned titanium crystalline can be committed as a ground excellent in the stacking tendency, and can grow up the titanium membrane formation which was excellent also in the early membrane formation conditions of a growth rate at the stacking tendency.
[0054] Therefore, titanium membrane formation of the thickness of choice excellent in the stacking tendency can be formed in a short time.
[0055] Moreover, it is made to form a platinum thin film in the aforementioned titanium thin film upper surface.
[0056] Therefore, although platinum has the priority stacking tendency originally, it can form the platinum thin film which was further excellent in the stacking tendency by working as a ground the aforementioned titanium thin film excelled [ground] in the stacking tendency. Moreover, since the aforementioned titanium thin film has adhesion in both the aforementioned substrate and the aforementioned platinum thin film, it can prevent exfoliation of the aforementioned substrate and the aforementioned platinum thin film.
[0057] Moreover, it is made to grow up a ferroelectric thin film into the aforementioned platinum thin film upper surface.
[0058] Therefore, when the aforementioned platinum thin film excellent in the stacking tendency works as a ground, the ferroelectric thin film excellent in the stacking tendency can be formed.

[Translation done.]

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, there were the following troubles in the conventional crystalline thin-film-fabrication method.
[0013] As mentioned above, in order to manufacture the titanium thin film 31, the platinum thin film 33, and PZT thin film 35 grade excellent in the stacking tendency, the crystal needed to be grown up on specific membrane formation conditions. On the specific membrane formation conditions that the crystal excellent in the stacking tendency can generally be grown up, the growth rate was slow.
[0014] Therefore, in order to obtain the thin film excellent in the stacking tendency, most time was required from crystal-growth speed being slow. Especially, it had become a problem when thickness was thick.
[0015] Therefore, although this invention solved the above-mentioned problem and shortened formation time, it is offering the method of forming the thin film which has the crystal structure excellent in the stacking tendency.

[Translation done.]

MEANS

[Means for Solving the Problem] After the manufacture method of the crystalline thin film concerning a claim 1 forms the first film which has the crystal structure excellent in the stacking tendency, it is characterized by forming the second film on the early membrane formation conditions of a growth rate.
[0017] The crystalline thin-film-fabrication method concerning a claim 2 is characterized by the first film and the second film being films of the same composition.
[0018] The crystalline thin-film-fabrication method concerning a claim 3 is characterized by the first film being a platinum film.
[0019] After the manufacture method of the crystalline thin film concerning a claim 4 grows up the seed crystal excellent in the stacking tendency in the state where it dissociated, it is characterized by forming the membrane formation considered as hope on the early membrane formation conditions of a growth rate.
[0020] The crystalline thin-film-fabrication method concerning a claim 5 is characterized by the aforementioned seed crystal and the thin film of hope being the same composition.
[0021] The crystalline thin-film-fabrication method concerning a claim 6 is characterized by the aforementioned seed crystal being a platinum film.
[0022] After the crystalline thin-film-fabrication method concerning a claim 7 forms the titanium crystalline excellent in the stacking tendency in the prepared substrate upper surface, it grows up a titanium crystal on the early membrane-formation conditions of a growth rate, and is characterized by to have the process which forms titanium membrane formation of the thickness of choice, the process which forms a platinum thin film in the aforementioned titanium thin film upper surface, and the process which grows up a ferroelectric thin film into the aforementioned platinum thin film upper surface.

[Translation done.]

OPERATION

[Function] After forming the first film excellent in the stacking tendency, it is made to grow up a crystal into the first film upper surface on the early membrane formation conditions of a growth rate by the crystalline thin-film-fabrication method concerning a claim 1, a claim 2, and a claim 3.
[0024] Therefore, the first film can be committed as a ground excellent in the stacking tendency, and the second film which was excellent also in the early membrane formation conditions of a growth rate at the stacking tendency can be grown up.
[0025] After growing up the seed crystal excellent in the stacking tendency in the state where it dissociated, it is made to grow up a crystal on the early membrane formation conditions of a growth rate on the aforementioned seed crystal by the manufacture method of the crystalline thin film concerning a claim 4, a claim 5, and a claim 6.
[0026] Therefore, the aforementioned seed crystal can be committed as a ground excellent in the stacking tendency, and can grow up the second film which was excellent also in the early membrane formation conditions of a growth rate at the stacking tendency.
[0027] After forming the titanium crystalline excellent in the stacking tendency in the prepared substrate upper surface, a titanium crystal is grown up on the early membrane formation conditions of a growth rate, and it is made to form titanium membrane formation of the thickness of choice by the manufacture method of the crystalline thin film concerning a claim 7.
[0028] Therefore, the aforementioned titanium crystalline can be committed as a ground excellent in the stacking tendency, and can grow up the titanium membrane formation which was excellent also in the early membrane formation conditions of a growth rate at the stacking tendency.
[0029] Moreover, it is made to form a platinum thin film in the aforementioned titanium thin film upper surface.
[0030] Therefore, although platinum has the priority stacking tendency originally, the platinum thin film which was further excellent in the stacking tendency can be grown up by working as a ground the aforementioned titanium thin film excelled [ground] in the stacking tendency. Moreover, the aforementioned titanium thin film has adhesion in both the aforementioned substrate and the aforementioned platinum thin film.
[0031] It is made to grow up a ferroelectric thin film into the aforementioned platinum thin film upper surface.
[0032] Therefore, when the aforementioned platinum thin film which was further excellent in the stacking tendency works as a ground, the ferroelectric thin film excellent in the stacking tendency can be grown up.

[Translation done.]

EXAMPLE

[Example] It is based on the manufacturing process of a memory cell 1, and the manufacture method of the crystalline thin film by which a laminating is carried out on the gate of the memory cell 1 of a ferroelectric nonvolatile storage as one example using the crystalline thin-film-fabrication method concerning this invention is explained below. A cross-section block diagram shows a manufacturing process to drawing 1 A, B, and C, drawing 2 A and B, and drawing 3 .
[0034] As shown in drawing 1 A, in order to form a memory cell 1, a silicon wafer 5 is prepared first.
[0035] Next, as shown in drawing 1 B and C, the titanium crystallinity thin film 3 of C shaft stacking tendency <001> is formed in the upper surface of a silicon wafer 5 by the electron-beam-evaporation method. In this case, on different conditions as follows, an electron-beam-evaporation method is divided into two processes, and is performed. At the first first process, temperature is made into 300 degrees C to 400 degrees C, for example, 350 degrees C, electron gun power is set as 180-300W, and the titanium crystalline 7 is grown up until thickness is set to about several nm as the first film. At the second following process, temperature is made into 500 degrees C to 600 degrees C, for example, 550 degrees C, electron gun power is set as 180-300W, the titanium crystallinity thin film 9 is grown up as the second film, and the titanium crystallinity thin film 3 of the thickness (about 50nm) of choice is obtained.
[0036] In addition, a growth rate is slow although the titanium crystal of C shaft stacking tendency <001> excellent in the stacking tendency can be grown up in the titanium crystal growth by the temperature conditions (350 degrees C) of the first process. Moreover, when growing up a titanium crystal on the temperature conditions (550 degrees C) of the second process, although a growth rate is early, the titanium crystal of <011> orientation usually grows. However, the titanium crystal of C shaft stacking tendency <001> can be grown up also on the temperature conditions of the second process by performing the second process following the first process in this example with an early growth rate. Therefore, the titanium crystallinity thin film 3 (about 50nm of thickness) of C shaft orientation <001> which was excellent in several minutes at the stacking tendency can be formed in the upper surface of a silicon wafer 5.
[0037] In addition, it is also good to form the seed crystal excellent in the stacking tendency in the state where it dissociated, in this example, although the titanium crystalline 7 is forming membranes to about several nm thickness as the first film instead. The titanium crystallinity thin film of C shaft stacking tendency <001> excellent in the stacking tendency can be formed in the upper surface in spite of the membrane formation conditions the crystal of <011> orientation grows up to be also in this case.
[0038] Moreover, in this example, although composition is growing up the second same film on the first film or seed crystal, the crystal of different composition as the second film can also be grown up.
[0039] Next, as shown in drawing 2 A, the platinum thin film 11 of <111> orientation is formed in the upper surface of the titanium crystallinity thin film 3 by CVD. In addition, the crystal excellent in the stacking tendency grows by carrying out priority orientation of the platinum irrespective of a ground originally. However, in this example, since platinum is grown up after forming as a ground the titanium crystallinity thin film 3 of C shaft stacking tendency <001> near the distance between grids of the platinum which has <111> orientation, the grown-up crystal of platinum shows a still better stacking tendency.
[0040] Moreover, ablation of the platinum thin layer 11 from a silicon wafer 5 can be prevented by having formed the titanium thin film 3 between the silicon wafer 5 and the platinum thin film 11 at this time.
[0041] Next, as shown in drawing 2 A, the PZT thin film 13 which is a ferroelectric thin film is formed in the platinum thin film 11 upper surface by the sol-gel method. Here, the formation method of the PZT thin film by this sol-gel method is performed as follows.
[0042] First, a sol solution is adjusted. A sol solution is adjusted to the mole ratio of Pb:Zr:Ti=1:0.58:0.48 in PZT.
[0043] Next, after applying a sol solution adjusted in the bottom of the conditions of 3000rpm by the spin coat method and drying on 100 degrees C and the conditions for 15 minutes, use the equipment of RTA (Rapid Thermal Anneeling), it is made to sinter on 750 degrees C and the conditions for 20 seconds among oxygen atmosphere, and the PZT thin film 13 of about 50nm of thickness is formed.
[0044] As mentioned above, after forming the platinum thin film 11 as the first film in this example, it is made to form the PZT thin film 13 which is a crystalline thin film as the second film. Therefore, the PZT thin film 13 which inherited the good stacking tendency of the platinum thin film 11 can be formed.
[0045] In addition, it is also good to form the platinum seed crystal in the state where it dissociated which was excellent in the stacking tendency instead of th platinum thin film. Th PZT thin film which inherited th stacking tendency of this platinum seed crystal also in this case can be form d. Moreover, it is better to us the seed crystal in th state where it dissociated without forming membranes in the meaning of lessening as the unnecessary component has come out, when not directly related to the function of an element like this platinum crystal.

[0046] Furthermore, the PZT thin film 15 is grown up into the PZT thin film 13 upper surface by the magnetron sputtering method (610 degrees C of temperature conditions), and the PZT thin film 17 of 200nm of thickness is formed.
[0047] As mentioned above, in this example, the PZT thin film 17 is divided into the process of two times, and is formed (with option). After forming the PZT thin film excellent in the stacking tendency which inherited the stacking tendency of a platinum thin film with the first sol-gel method as the first film, the sputtering method is used, a PZT crystal is grown up as the second film, and thickness of the PZT thin film 17 is set to 200nm.
[0048] In addition, next, after making the platinum thin film 19 deposit on the PZT thin film 17 upper surface by the sputtering method, the crystalline titanium thin film 8, the platinum thin film 11, the PZT thin film 17, and the platinum thin film 19 are fabricated by using a resist as a mask and **********ing. next, the platinum thin film 19 — a mask — carrying out — an arsenic or Lynn — an ion implantation — and thermal diffusion is carried out and n+ type drain layer 21 and n+ type source layer 23 are formed A memory cell is formed as mentioned above.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is a manufacturing process view for the manufacture method of the crystalline thin film by one example of this invention being shown.
[Drawing 2] It is a manufacturing process view for the manufacture method of the crystalline thin film by one example of this invention being shown.
[Drawing 3] It is a manufacturing process view for the crystalline thin film by one example of this invention being shown.
[Drawing 4] It is a manufacturing process view for the conventional crystalline thin film being shown.
[Drawing 5] It is a manufacturing process view for the conventional crystalline thin film being shown.
[Drawing 6] It is a manufacturing process view for the conventional crystalline thin film being shown.
[Description of Notations]
7 ... Titanium crystalline
9 ... Titanium crystallinity thin film
3 ... Titanium crystallinity thin film
11 ... Platinum thin film
13 ... PZT thin film
15 ... PZT thin film
17 ... PZT thin film

[Translation done.]